

NEW SPECIES IN THE PHACELIA CREMULATA
GROUP (HYDROPHYLLACEAE)¹

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While preparing a taxonomic revision of the *Phacelia cremulata* group it was necessary to investigate the relationships of several taxa in southern Utah, northern Arizona and Mexico. These investigations demonstrated the presence of several previously undescribed taxa. These areas are well known for their varied geology, topography and climate. They have also been some of the least botanized and most poorly understood localities within the range of the *P. cremulata* group. Therefore, it is not surprising that new species are present, particularly in a genus which contains many taxa with restricted distribution. The purpose of this paper is to present the diagnoses, descriptions, distributions, and illustrations of the proposed new taxa.

The herbaria where specimens are deposited are abbreviated according to Lanjouw and Stafleu (1964). Those herbaria not listed in Lanjouw and Stafleu are as follows: Dixie Junior College, St. George, Utah (DIX), Weber State College, Ogden, Utah (WSC), and West Texas State University, Canyon, Texas (WTS).

The author is grateful to the curators of herbaria that were visited or who sent loan material for this study, and to Mrs. Kaye Thorne for preparation of the illustrations.

Phacelia constancei Atwood sp. nov.

A *P. palmeri* differt caulibus brevioribus, foliis angustioribus et revolutioribus, et caulibus rubellis pilioribus et ramis lateralibus frondosioribus.

Herba biennis erecta, 1.5-4.3 dm alta, frondosa omnino; folia petiolata (pro parte maxima), 1.0-10 cm longa, 0.3-

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1.5 cm lata, involuta, e undulata ad pinnatifida, lineares lanceolata, hirsutula supra, pilis glandularis dispersis; caules crasses, simplices vel ramosi omnino, rubelli, e hirsutuli ad hirsuti, et minute glanduliferi; inflorescentia, cymarum scorpiodorum compositorum; pediceli usque ad 1 mm longi; sepala e elliptica ad oblanceolata, 3-4 mm longa, hirsutuli ad hirsuti et stipitata glandulifera; corolla tubularis, 5-6 mm longa; stamina exserta 3-4 mm; stylus furcatus pubescens infimus $1/3$, exsertus 3-4 mm stamina longior; capsula subglobosa, hirsutula et glandulifera omnino, sepala brevior; semina 4, nigricantia, 2.5-2.8 mm longa, 1.0-1.2 mm lata, elliptica, margines corrugati, pagina ventralis foveolata, excavata et divisa porca prominens, porca lata una corrugata, pagina dorsalis foveolata.

TYPE: **Arizona:** COCONINO COUNTY: 1 mi north of Fredonia, on clay hills, growing with *Sarcobatus*, *Lycium*, *Astragalus*, and *Phacelia corrugata*, 27 May 1968, *D. Atwood* 1385A (HOLOTYPE: BRY; ISOTYPES: ARIZ, ASC, CAS, DIX, GH, NY, POM, RM, UC, US, UT, UTC, WSC).

Additional materials examined: **Arizona:** MOHAVE COUNTY: ca 19 mi south of Kanab Indian Reservation (southern boundary) on road to Tuweep junction, 27 May 1969, *D. Atwood* 1765, (BRY); 5 mi northeast of Tuweep, 17 August 1946, *K. F. Parker, et al.* 6254, (GH, NY, POM, US); ca 4 mi north of Tuweep junction, 27 May 1969, *D. Atwood* 1761, (BRY, CAS); 1 mi north of Fredonia, 5 June 1968, *D. Atwood* 1529, (BRY, GH, UC); 1 mi north of Fredonia, 27 May 1969, *D. Atwood* 1785, (ARIZ, BRY, CAS, NY, US, UTC, WSC); **Utah:** KANE COUNTY: ca 30 mi east of Kanab along Hwy 89, mi post 30, 6 June 1968, *D. Atwood* 1532, (BRY, CAS, GH, NY, US); 15 mi east of Kanab, 5 June 1969, *D. Atwood* 1739A, (ARIZ, BRY, US, UT); 15 mi east of Kanab, 5 June 1942, *Ripley & Barneby* 4836, (CAS, RSA); 20 mi east of Kanab, 5 June 1969, *D. Atwood* 1792B, (BRY, CAS, GH, NY, POM, RM, US); ca 32 mi east of Kanab along Hwy 89, 6 June 1968, *D. Atwood* 1532A, (BRY, POM, RSA); ca 3.7 mi east of Skutumpah-Alton junction at head of Johnston Canyon (R.4. 5W., T.40S.), 7 June 1969, *D. Atwood* 1801A, (BRY).

Taxonomically, *Phacelia constancei* (Figure 1, Map 1) appears to be most closely related to *P. palmeri* Torr. ex S. Wats., but is distinguished from that species by the smaller growth form, narrower and more revolute leaves, the stems are reddish with shorter and fewer hairs and the lateral inflorescence branches are more leafy.

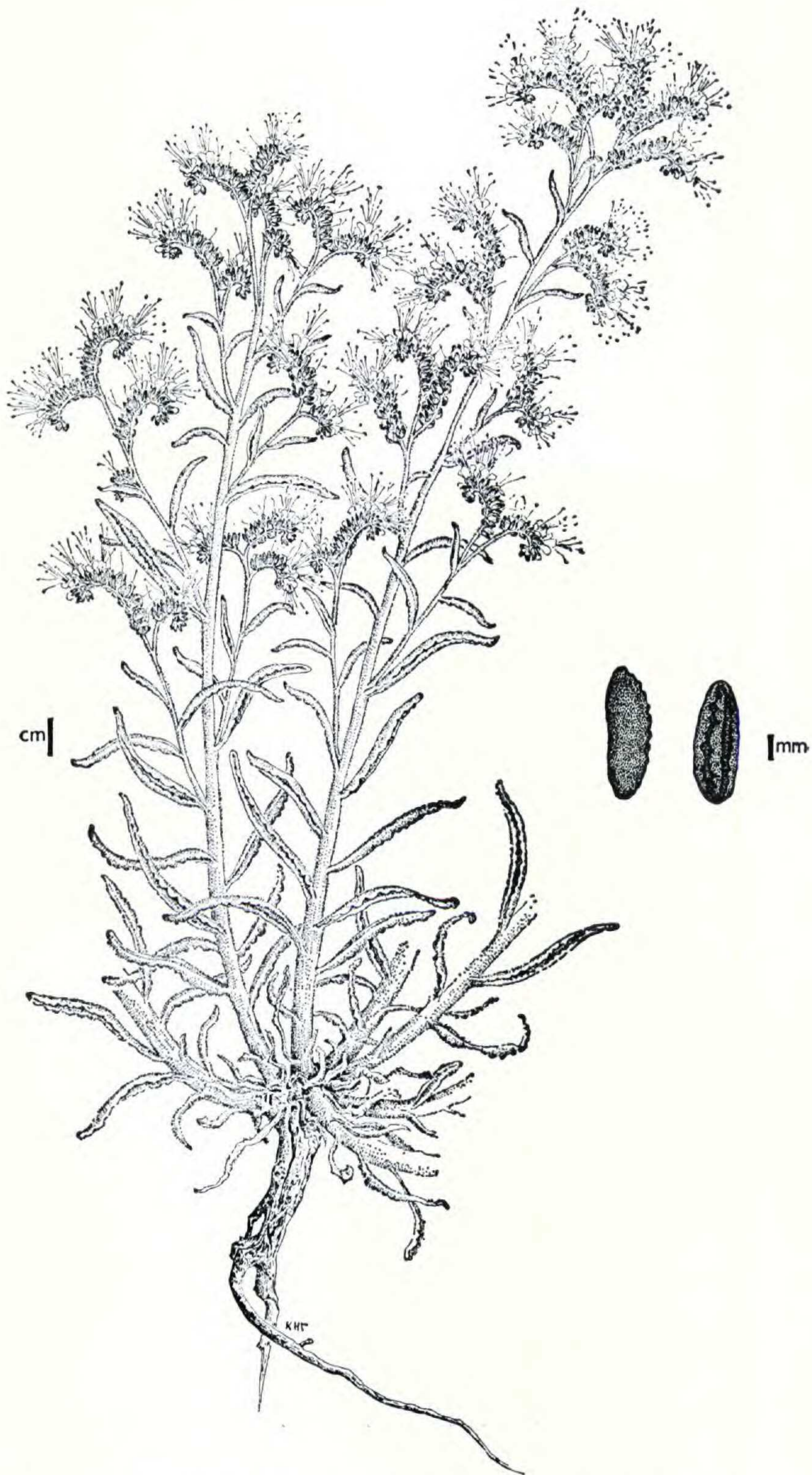
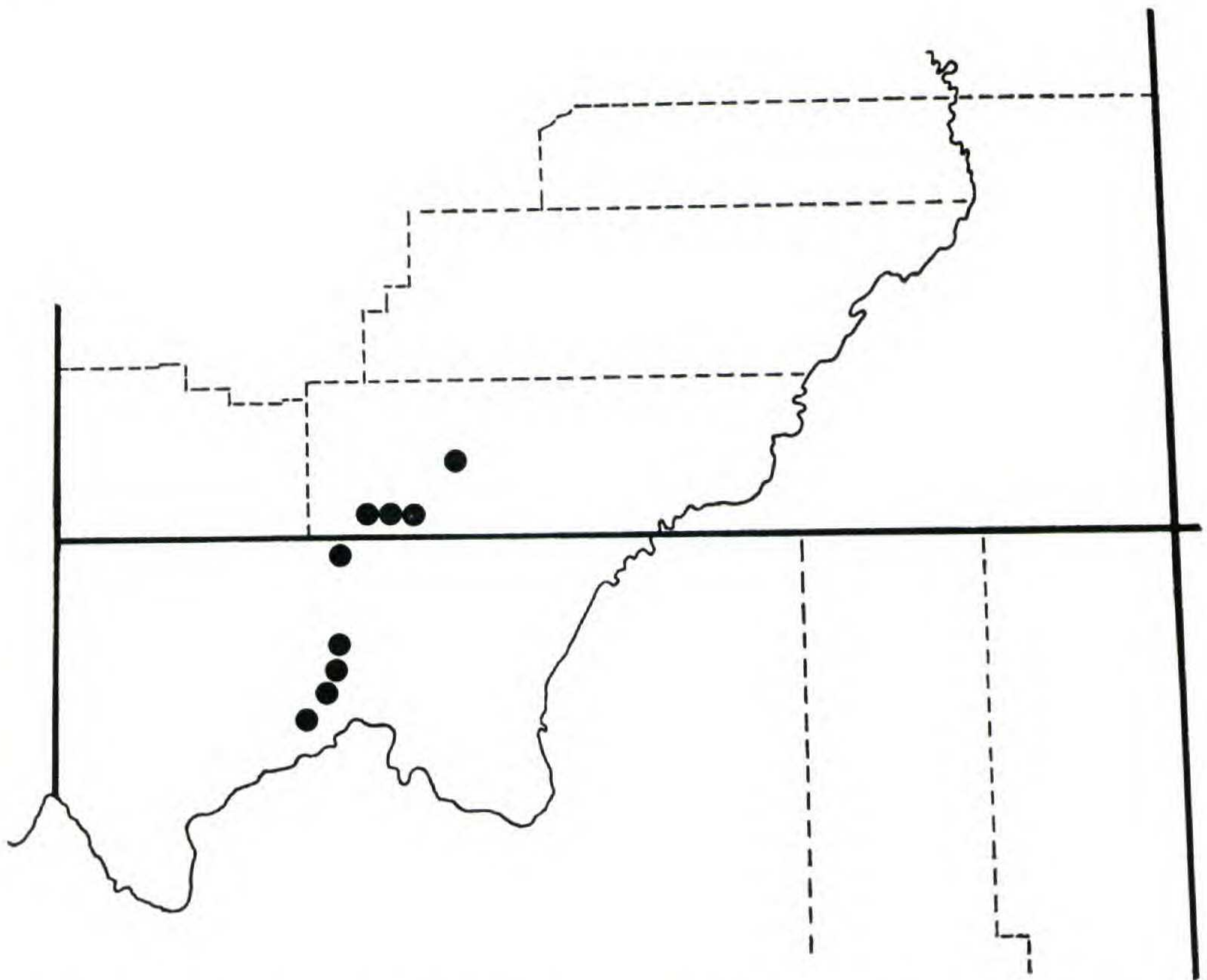


Fig. 1. *Phacelia constancei*. Habit and seed of plant.



Map 1. Southern Utah and northern Arizona. Range of *P. constancei*.

The latter occurs from Mohave County, Arizona, west to Washington and Iron County, Utah, and in Clark County, Nevada. The new taxon is known only from restricted areas in Mohave County, Arizona north to Kane County, Utah. Both species grow on alkaline clay bluffs and flats of the Moenkopi Formation, late May to mid August. Chromosome voucher specimen ($n=11$): Tuweep Valley, 5 mi ne. of Tuweep, 17 August 1946, *K. F. Parker et al.* 6254, (UC).

This species is named in honor of Dr. L. C. Constance, University of California at Berkeley, who has made numerous important contributions in the genus *Phacelia*.

***Phacelia rafaensis* Atwood sp. nov.**

A *P. utahensis* differt corolla tubularo diluta et canaliculata lobis aliquantum expansis, staminibus et stylis exsertis tantum 3-5 mm, filis et antheris tristis, semine porca interdum corrugata.

Herba biennis, erecta, 0.8-5.4 dm alta; caules crassi simplices vel interdum ramosi basi, e olivacei ad brunnei glandiferi et hirsuti; folia basalia petiolata dentata ad pinnatifida, 2-7 cm longa, 0.5-1.5 cm lata, strigosa ad hirsuta, folia caulina sessilia, undulati-crenata ad dentata, oblonga ad lanceolata, 1.0-10 cm longa, 0.5-3.5 cm lata, strigulosa ad hirsuta et sparsim stipitati-glandulifera; inflorescentia terminalis proparte maxima interdum axillaris, paniculata; flores fere sessiles; sepala oblonga ad spathulata, 3-4 mm longa in fructis, 1.0-1.7 mm lata, glandulifera et hirsuta; corolla tubularis pallida, 5-6 mm longa; stamen et stylus exsertus 3-5 mm; stylus $\frac{3}{4}$ longitudinis, pubescens infernus $\frac{1}{2}$; capsula globosa, 4-5 mm longa, stipitati-glandulifera et hirsuta; semina 4, elliptica ad oblonga, 3.4-4.0 mm longa, 1.5-2.0 mm lata, pagina ventralis alveolata pallidior pagina dorsalis, excavata et divisa porca prominenti, porca lata una corrugata, margines integrae, pagina dorsalis brunnea et alveolata radose.

TYPE: **Utah**: WAYNE COUNTY: Capital Reef National Monument, red clay hills (Moenkopi Formation) southeast of visitor center, 12 June 1969, *D. Atwood & L. C. Higgins* 1834, (HOLOTYPE: BRY; ISOTYPES, ARIZ, ASC, B, BRY, CAS, COLO, DIX, GH, JEPS, MEXU, NY, POM, RM, RSA, UC, US, UT, UTC).

Additional materials examined: **Arizona**: COCONINO COUNTY: Lee's Ferry, 16 June 1890, *M. E. Jones* s.n., (POM); 2 mi w. of Navajo Bridge, 12 May 1955, *Ripley & Barneby* 12664, (CAS); MOHAVE COUNTY: 2 mi e. of Fredonia, 6 June 1942, *Ripley & Barneby* 4362, (RSA); ca 4 mi w. of Fredonia, mi post 22, 27 May 1968, *D. Atwood* 1390, (ARIZ, ASC, BRY, CAS, POM, US); 1 mi n. of Fredonia, 5 June 1968, *D. Atwood* 1530, (BRY, B, POM); ca 4 mi s. of Fredonia-Pipe Springs road, 13 May 1952, *E. McKlintock* 52-600, (CAS); **Utah**: EMERY COUNTY: Chinle Formation, at jct of Buckhorn Wash & San Rafael River Canyon north of river, 30 May 1970, *Welsh, Atwood & Moore* 9819, (ARIZ, ASC, B, BRY, CAS, GH, NY, RM, RSA, UC, US, UT, UTC, WSC); 2 mi s. of San Rafael River Bridge, 16 June 1969, *D. Atwood* 1843, (ARIZ, ASC, B, BRY, GH, NY, US, WSC); 11 mi n. of Goblin Valley turn off on Temple Mountain road from US 24, thence 43 mi s.w. on mining road, 17 June 1969, *D. Atwood* 1855, (BRY, RM); R.9E., T.26S., San Rafael Swell, 17 June 1969, *D. Atwood* 1847, (ARIZ,

ASC, B, BRY, CAS, GH, NY, UC, US, UT, UTC); ca 13 mi e. of Buckhorn Wash, north of San Rafael River, 30 May 1970, *Welsh, Atwood & Moore* 9846, (BRY); ca 5 mi e. of Buckhorn Wash along road north of San Rafael River, 30 May 1970, *Welsh, Atwood & Moore* 9844, (ARIZ, B, BRY, CAS, GH, NY, US); ca 2 mi w. of San Rafael River Bridge at jct. of Buckhorn Wash and San Rafael River, 1 June 1970, *Welsh, Atwood & Moore* 9903, (BRY, NY, US, WSC); WASHINGTON COUNTY: 11 mi w. of Hurricane, 2 May 1942, *F. Gould* 1681, (CAS, UC); near Virgin, 10 May 1941, *Eastwood & Howell* 9200, (CAS); e. of Bloomington, 10 April 1970, *Welsh, Atwood & Matthews* 9535, (BRY, NY, UC, WSC); 2 mi e. of Hurricane, 27 May 1968, *D. Atwood* 1409, (BRY, CAS); Rockville, 12 May 1941, *Eastwood & Howell* 9327, (CAS, GH); 4 mi s.w. of Saint George, 27 May 1968, *D. Atwood* 1417, (BRY); Moenkopi Formation at Bloomington, 3 May 1970, *Welsh, Atwood & Matthews* 9694, (BRY); clay hills n. of Bloomington, 25 May 1969, *D. Atwood* 1698, (ARIZ, ASC, B, BRY, CAS, GH, JEPS, NY, RM, UC, UTC, WSC); ca 5 mi s.w. of St. George, 7 April 1968, *Higgins* 1244, (BRY); WAYNE COUNTY: Capital Reef Wash 2 mi s.e. of Fruita, 6 May 1940, *B. Maguire* 18146, (CAS, NY, UC, UTC); 3 mi s. of Highway 24 on Notom Road, 17 June 1969, *D. Atwood* 1860, (ASC, BRY, CAS, GH, RSA, UC, UT, US, WSC); Moenkopi Formation at Fruita, 10 May 1969, *Welsh Atwood & Higgins* 8968, (BRY, CAS, RM, RSA, UC, US, UT); 3 mi w. of Fruita, 4 June 1953, *R. McVaugh*, 14438, (CAS, NY, UC).

Phacelia rafaelensis appears to be related to *P. utahensis* but differs from that species as indicated in the diagnosis. *P. utahensis* is endemic to the Arapien Shale Formation in Sevier and San Pete County, Utah, whereas *P. rafaelensis* (Figure 2, Map 2) occurs from Emery County south to Kane County, Utah and Mohave County, Arizona and east to Washington County, Utah. It grows on clay hills of the Moenkopi Formation. mid April to mid June.

This species is named for the San Rafael Swell, a floristically unique area, in Emery County, Utah.

***Phacelia howelliana* Atwood sp. nov.**

A. *P. corrugata* differt corollis pusillioribus et tubo albo, seminibus diluti-marginatis dorsalibus laevibus, plantis brevioribus et plerumque ramosis et frondosis basi.

Plantae annuae, 0.9-2.3 dm altae; caules pro parte maxima et frondosi ad basin versus, glandulifera et aliquot pilii longiores simplices praesenta; folia e late oblonga ad ovales,

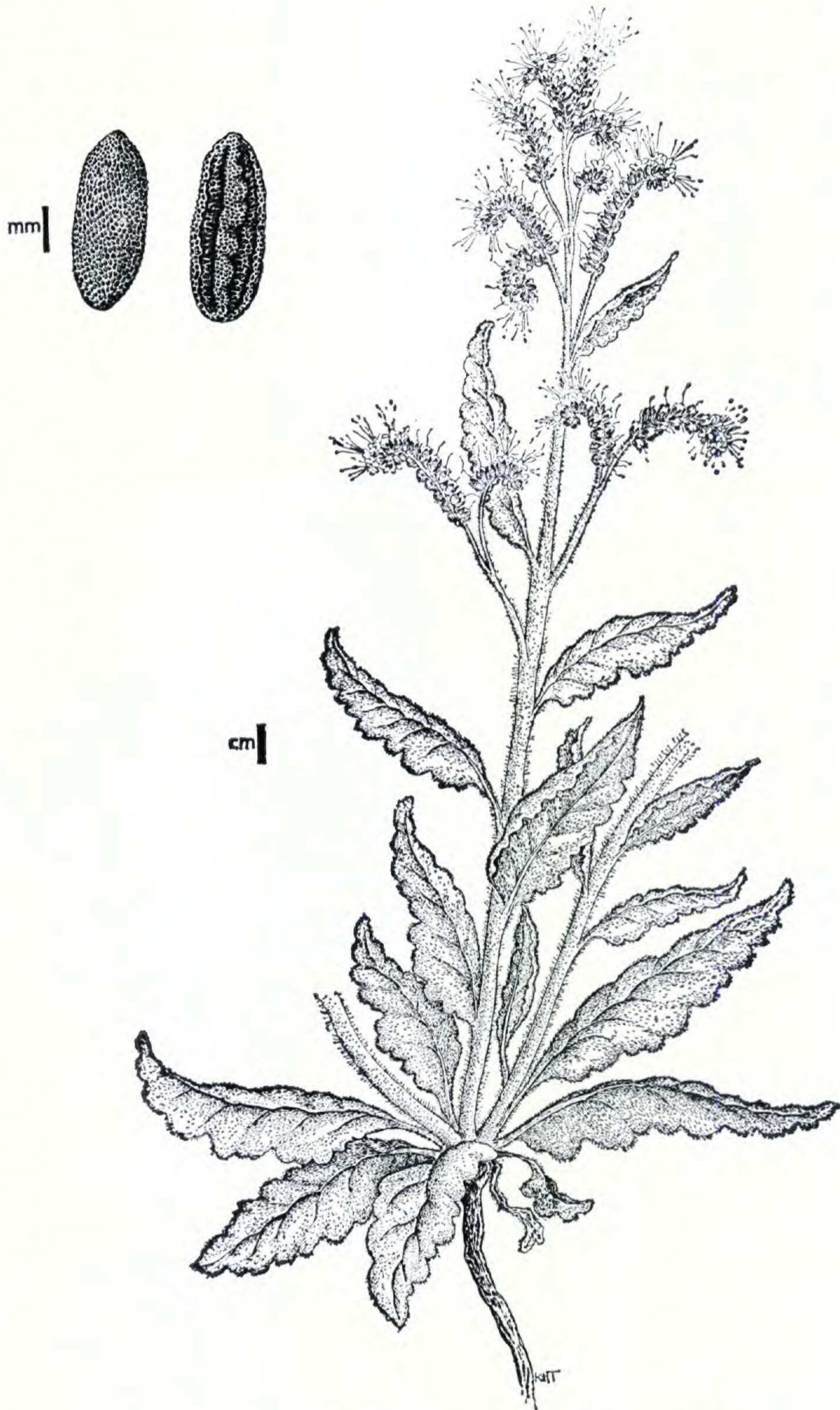
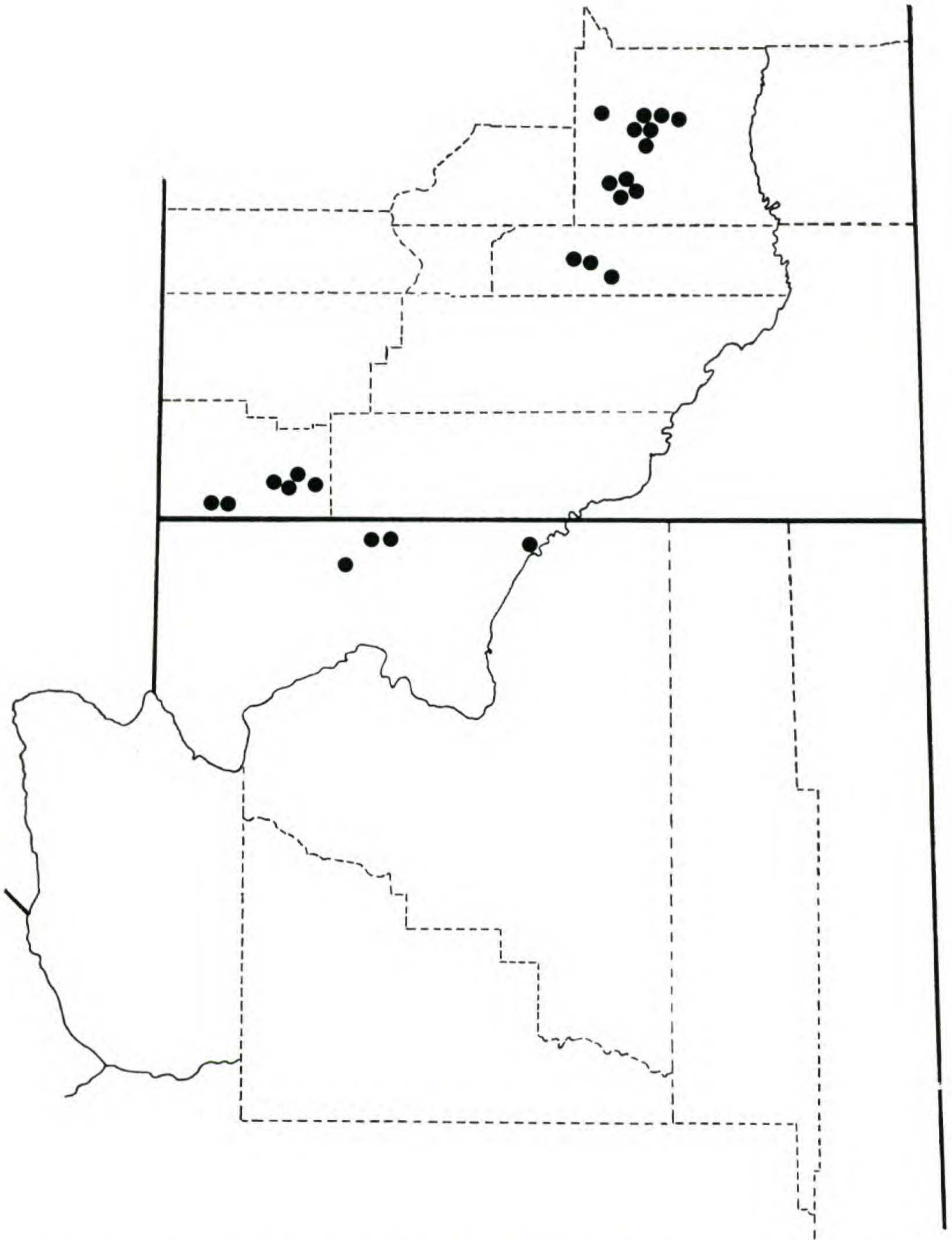


Fig. 2. *Phacelia rafaensis*. Habit and seed of plant.



Map 2. Southern Utah and northern Arizona. Range of *P. rafaensis*.

2-6 cm longa, 1.0-2.5 cm lata, irregulariter crenata ad lobata, strigosa et leviter glandulifera, petiolus usque ad 5.0 cm longa; inflorescentia cymarum scorpiodorum compositorum, pedicelli usque ad 2.0 mm longi; sepala linearia ad anguste oblanceolata, 3.5-4.0 mm longa, 1.0-1.5 mm lata, glandulifera et hirsuta; corolla 5-6 mm longa, 6-7 mm lata, rotata ad infundibuliformis, lobi pallidi violacei, tubus albus, stamina et stylus exsertus 3-4 mm, stylus breviores stamina furcatus $\frac{3}{4}$ longitudo pubescens infirmus $\frac{1}{4}$; capsula oblonga ad subglobosa glandularis et hirsutulosa apprime versus apex; semina 4, brunnea, 3.2-4.0 mm longa, 1.4-1.8 mm lata, elliptica, margines corrugati usque involuti ad complanati, pagina ventrali foveolata, excavata et divisa porca prominens, interdum curva lata una et vix corrugata, pagina dorsalis prophyreus laevis et margo pallida circumtineta.

TYPE: Utah: SAN JUAN COUNTY: ca 0.4 mi n. of Bluff, Utah on highway 163, in mouth of canyon on rocky-sandy-clay soil, 13 May 1970, *D. Atwood* 2454, (HOLOTYPE: BRY; ISOTYPES, ARIZ, ASC, B, BRY, CAS, GH, NY, RM, UC, US, UTC).

Additional materials examined: **Utah: GRAND COUNTY:** 13 mi n. of Moab, 15 June 1944, *A. H. Holmgren & S. Hansen* 3319, (NY); Moenkopi Formation, T.25S., R.23E., in Castle Valley, 5 June 1970, *Welsh, Atwood & Moore* 9957, (ARIZ, BRY, CAS, WTS); Arches National Monument, vicinity of Courthouse Wash, 2 May 1963, *G. L. Pyrah, et al.* 71, (BRY); Potash Plant, 20 April 1962, *S. L. Welsh*, 1670A, (BRY); **SAN JUAN COUNTY:** Bluff, near the Navajo Twins, 29 April 1961, *D. Bright* 55, (BRY); Bluff, 24 May 1919, *M. E. Jones* s.n., (POM); along road just w. of Monument Valley Hospital, 15 May 1970, *D. Atwood* 2511, (ARIZ, ASC, B, BRY, CAS, DIX, GH, JEPS, NY, POM, RM, RSA, UC, US, UTC, WSC); Goulding Trading Post); 26 June 1948, *J. T. Howell* 24687, (CAS); canyon of the San Juan River between Bluff and the Colorado River, *P. Thompson* s.n., May 1941, (CAS); dark canyon-Cataract Canyon, 1 July 1938, *E. Clover & M. Jotter* 2143A, (GH); ca 2 mi e. of Bluff, 12 May 1944, *A. H. Holmgren* 3187, (UTC).

This entity is related to *P. corrugata* A. Nels. which ranges throughout most of Utah and extends into Colorado, northern New Mexico and northern Arizona. It is distinguished from *P. corrugata* by its low much branched growth

form, smaller corolla and white tube. The leaves are mostly basal and the seeds are different as indicated in the diagnosis and general description. *P. howelliana* (Figure 3, Map 3) is known only from San Juan and Grand Counties, Utah where it grows in red sandy, gravelly or sandy-clay soils at ca 4500 to 5000 feet. It probably occurs in Colorado near Moab and undoubtedly in Monument Valley in

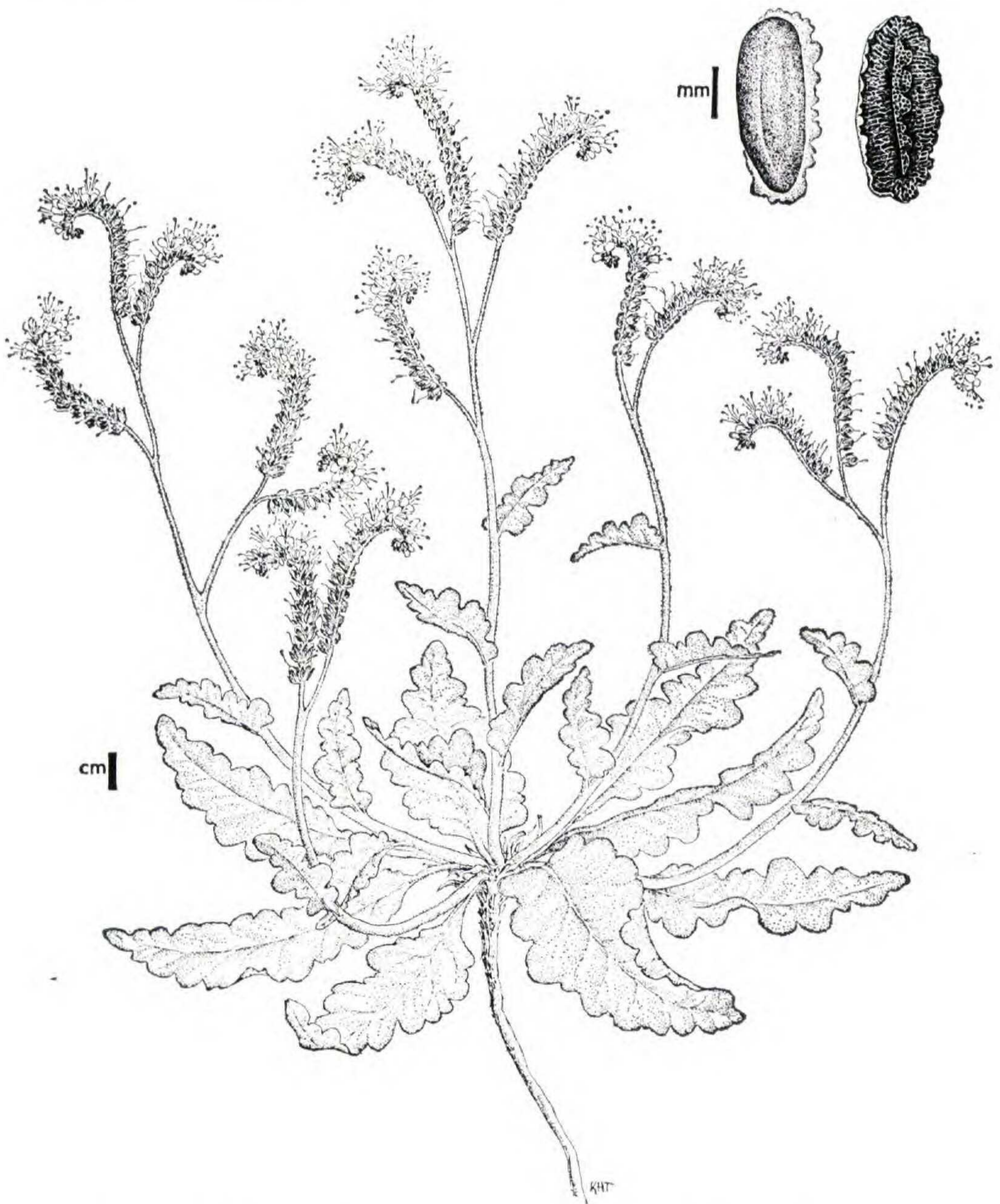
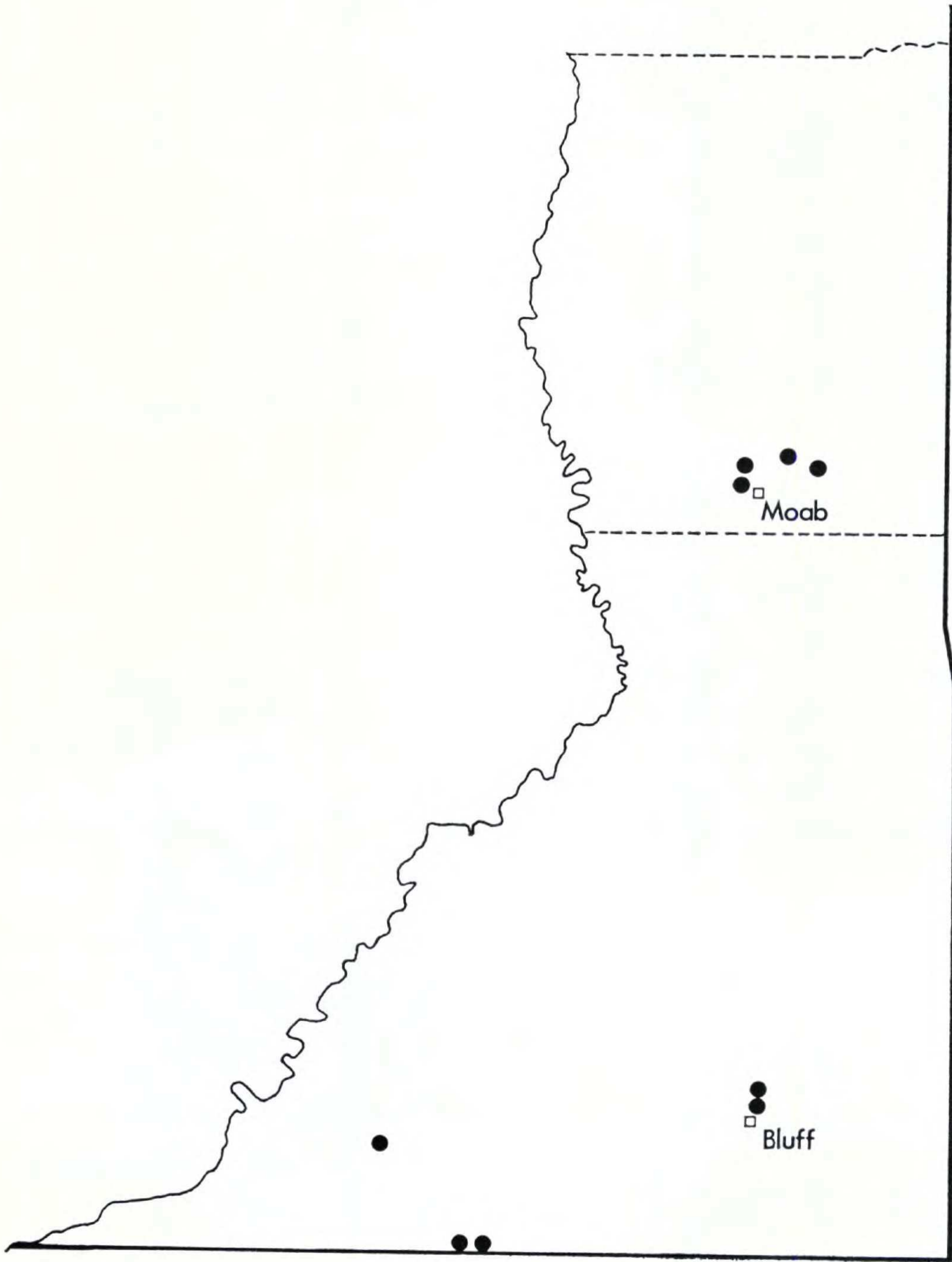


Fig. 3. *Phacelia howelliana*. Habit and seed of plant.



Map 3. Southern Utah, Grand and San Juan Counties. Range of *P. howelliana*.

Arizona, although no specimens have been seen from either area.

This species is named in honor of John Thomas Howell at the California Academy of Sciences, who has published many important works within the genus *Phacelia*.

***Phacelia vossii* Atwood sp. nov.**

Plantae perennis, 2.1-7.3 dm altae; caules erecta e caudice ligneo, hirsutis ad hirsutulis et stipitati-glanduliferis pilis; folia lineara ad lanceolata, 2.0-11 cm lata, revoluta, pagina ventralis glandulifera dense, pagina dorsalis hirsuta et stipitate-glanduliferis dispersis, margines dentatae ad irregulariter dentatae, petiolata, petiolus usque ad 1.5 cm longa; inflorescentia terminalis vel secus caules dispersa usque ad $\frac{1}{2}$ longitudo vel, minus, simplex ad cymarum scorpiodorum compositorum, racemi individua usque ad 7.5 cm longa per fructus, pedicelli usque ad 2.0 mm longa per fructus, glandulifera et hirsuta; corolla tubularis (campanulata ?), diluta purpurascens ad albida (?), 5.5 mm longa; sepala oblanceolata ad spathulata, 4-6 mm longa, 1.5-2.0 mm lata, glandulifera et hirsuta; stamina exserta; stylus exserta circa 2.0 mm stamina longior, circa 9.0 mm longa, furcatus $\frac{3}{4}$ longitudo, inferna $\frac{1}{4}$ pubescens; capsula ovata, 3.7 mm longa, 2.5-2.7 mm lata, glandulifera et strigosa; semina 4, elliptica ad oblonga, 2.5-3.1 mm longa, 1.0-1.4 mm lata, margines integra ad corrugata parte, pagina dorsalis foveolata, pagina ventralis foveolata et porca prominentia centrale corrugata, porca excavata utrinque.

TYPE: **Mexico:** NUEVO LEON: Sierra Madre Oriental, calcite and limestone hills beyond Pablillo toward Santa Clara, about 15 mi s.w. of Galeana, sparse in arroyos, flowers light purple, 18 July 1934, *C. H. & M. T. Mueller* 1075, (HOLOTYPE: GH; ISOTYPE, MEXU).

Additional materials examined: **Mexico:** NUEVO LEON: Hacienda Pablillo, Galeana, 13 August 1936, *Mary Taylor* 156, (UC, NY).

Phacelia vossii (Figure 4, Map 4) is known only from the type collections by Galeana in the State of Nuevo Leon, Mexico. It apparently grows in calcite and limestone soils.

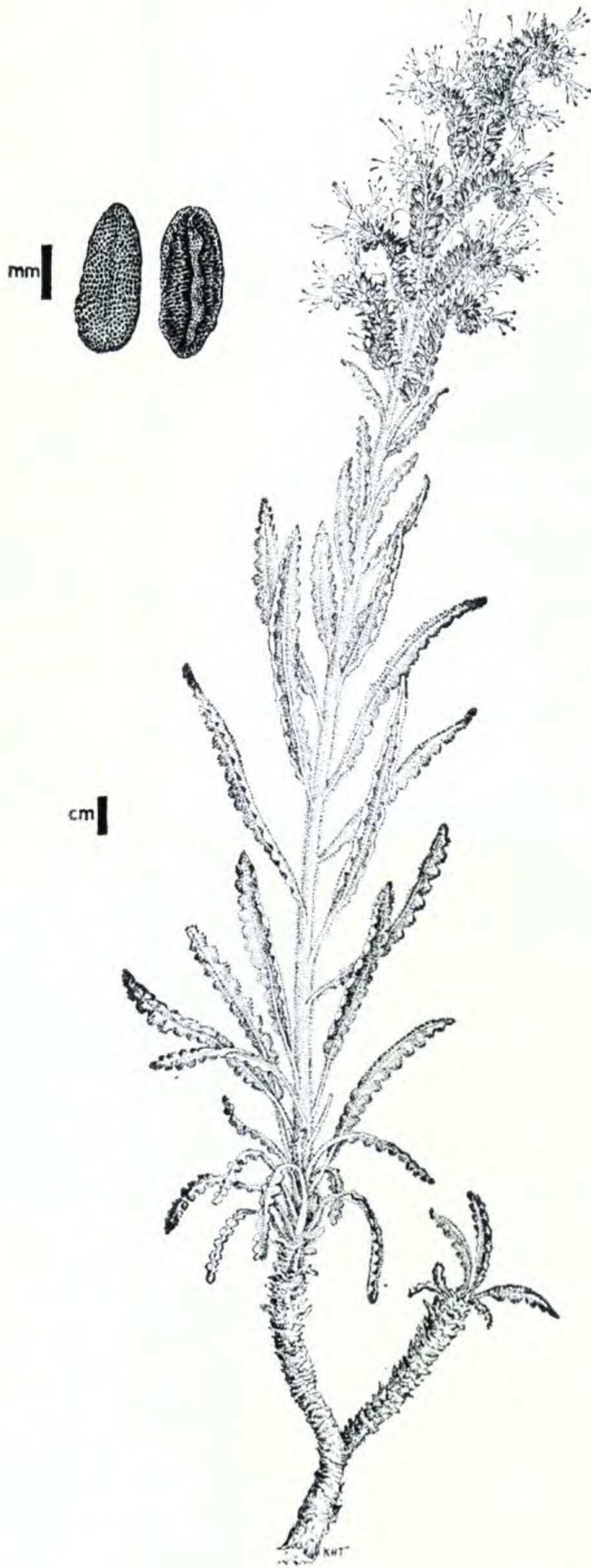
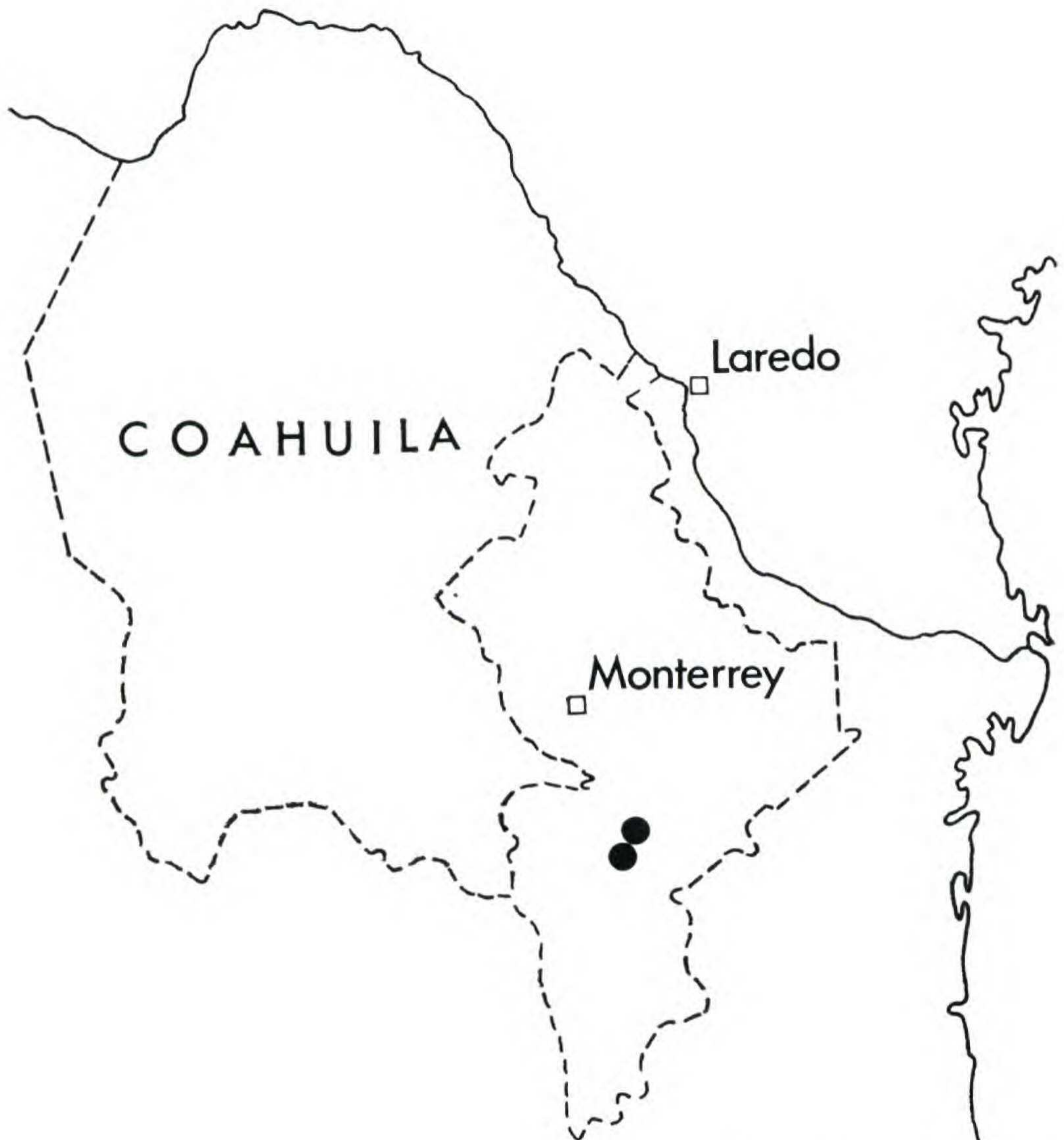


Fig. 4. *Phacelia vossii*. Habit and seed of plant.



Map 4. Mexico, States of Coahuila and Nuevo Leon. Range of *P. vossii*.

The flower color is not apparent in the specimens at hand, but the label of the type material indicates that it is a light purple. Other members of the *crenulata* group which possess a pale corolla are often also whitish at times.

This taxon appears to be related to *P. pinnatifida* Griseb. According to Brand (1913) the latter occurs in the Andes of South America in Peru, Boliva, and Argentina, from 3000 to 3800 meters. The specimens cited were identified as *P. integrifolia* Torr., however *P. vossii* is easily distin-

guished from the former by its evident perennial habit, pale more or less tubular corollas, smaller corrugated seeds and more densely pubescent herbage.

This species is named in honor of John Voss who revised the *crenulata* group in 1937.

Phacelia welshii Atwood sp. nov.

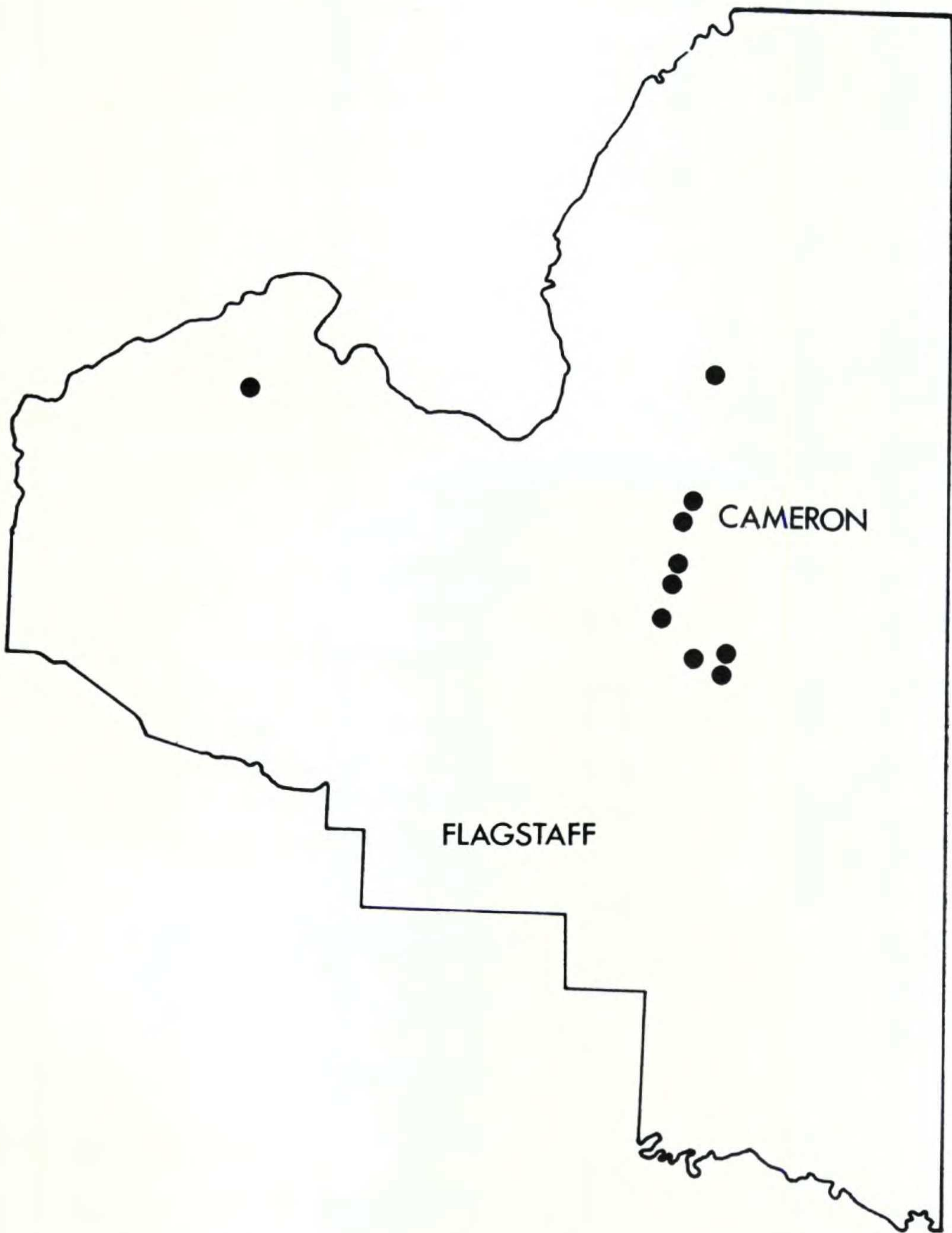
Plantae annuae, 1.0-4.5 dm altae; caules plus minusve flavo-virentes, simplices vel ramosi frondosi, hirsuti et dense tecti multi-cellularis stipitatis, glandibus; folia oblonga ad lanceolata, 1.5-8.0 cm longa, 0.5-2.7 cm lata, hirsuta et dense glandulifera, margines undulatae crenatae vel dentatae saepe revolutae, folia basales fasciculata, petiolata, petiolus 2.0 cm longus or minus, folia caulina sessiles vel fere sic, saepe cordata ad basim; inflorescentia cymarum scorpiodorum compositorum, terminalis ad extrema principalis caulis et rami lateralis, dense glandulifera et hirsuta, racemi individui congesta, sed laxe per fructus, usque ad 1.0 dm longa, pedicelli usque ad 1.5 mm longa; sepala spat lata glandulifere; corolla campanulata, purpurascens ad violacea, 5.0-6.0 mm longa et lata, pubescentia; anthera lutea; stylus exserta circa 8.0 mm, furcatus $\frac{3}{4}$ longitudo, inferna $\frac{1}{4}$ hirsutulosa et glandulifera; semina 4, oblonga, ventraliter brunnea ad prophyreus dorsale, foveolata, 2.8-3.4 mm longa, 1.3-1.5 mm lata, pagina ventrali pagina dorsalis pallidior quam et porcis prominentis, porca corrugata lata una, margines corrugatae et plus minusve revolutae.

TYPE: Arizona: COCONINO COUNTY: along highway 89 north of Gray Mountain, on red shale (also common south of town on red shale), 19 May 1970, *D. Atwood* 2608, (HOLOTYPE: BRY; ISOTYPES, ARIZ, ASC, B, BRY, CAS, COLO, DIX, GH, NY, POM, RM, RSA, UC, US, UT, UTC, WSC, WTS).

Additional materials examined: **Arizona: COCONINO COUNTY:** 2.5 mi w. of highway 89-64 jct, red shale, 19 May 1970, *D. Atwood* 2611, (ARIZ, ASC, B, BRY, CAS, COLO, DIX, GH, NY, UC, US, WSC, WTS); 10 mi n. of Wuptaki National Monument jct with highway 89, 19 May 1970, *D. Atwood* 2605, (ARIZ, ASC, B, BRY, CAS, GH, NY, POM, RM, RSA, UC, US, UT, UTC, WTS); ca 1.5 mi n.w. of Headquarters of Wuptaki Na-



Fig. 5. *Phacelia welshii*. Habit and seed of plant.



Map 5. Coconino County, Arizona. Range of *P. welshii*.

tional Monument along highway on red shale, growing with *Ephedra*, *Hilaria*, *Oryzopsis*, blue grama, *Atriplex* and apache plume, 18 May 1970, *D. Atwood* 2601, (ASC, BRY, CAS, US, WSC); rocky limestone areas above the Little Colorado River, 6 May 1961, *D. Demaree* 44391, (CAS, UC); red shale hills along road ca 0.5 mi n. of headquarters of Wupatki National Monument, 18 May 1970, *D. Atwood* 2598, (ARIZ, B, BRY, CAS, COLO, DIX, GH, NY); Willow Springs n. of Cameron, 7 June 1942, *Ripley & Barneby* 4875, (CAS); red shale 11 mi s. of Cameron, 20 June 1948, *Howell* 24397, (CAS).

P. welshii (Figure 5, Map 5) is probably most closely related to *P. corrugata* and *P. utahensis*. It can be distinguished from the former by its broader, dark brown seeds, long (up to 1.3 mm long), flattened, multicellular, stipitate glands and different leaves. Typically *P. corrugata* is a more northern plant but is not uncommon in Coconino County. The new taxon can be differentiated from *P. utahensis* by its more open inflorescence, corrugated seeds, and broader, shorter, densely glandular leaves. *P. utahensis* is endemic to the Arapien Shale Formation in Utah.

This species is named in honor of Dr. Stanley L. Welsh, Brigham Young University, for his rich contributions toward the flora of the Intermountain area, and for his encouragement and invaluable help throughout the course of this study.

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